CLAIMS

What is claimed is:

1. A miniaturized sensor device, comprising:

a thin film membrane having a first surface and a second surface;

one or more resistive thin film heater/thermometer devices disposed directly or indirectly adjacent to at least one of the first surface of the thin film membrane and the second surface of the thin film membrane;

a frame disposed directly or indirectly adjacent to the second surface of the thin film membrane, wherein one or more internal surfaces of the frame define at least one cell having at least one opening;

a thin film layer disposed directly or indirectly adjacent to the frame; and

a sensing layer disposed directly or indirectly adjacent to the thin film membrane.

2. The sensor device of claim 1, wherein the thin film membrane comprises a material selected from the group consisting of at least one dielectric material, polysilicon, and a combination of at least one of the foregoing materials.

3. The sensor device of claim 2, wherein the at least one dielectric material comprises a material selected from the group consisting of silicon, silicon oxinitride, parylene, polyimide, and a combination of at least one of the foregoing materials.

4. The sensor device of claim 1, wherein the thin film membrane has a thickness of between about 50 nm and about 5 microns.

5. The sensor device of claim 1, wherein the one or more resistive thin film heater/thermometer devices each comprise a material selected from the group consisting of at least one metal, polysilicon, heavily-doped silicon, silicon carbide, and a combination of at least one of the foregoing materials.

6. The sensor device of claim 5, wherein the at least one metal comprises at least one of platinum, titanium, gold, chromium, nickel, copper, and aluminum.

7. The sensor device of claim 1, wherein each of the one or more resistive thin film heater/thermometer devices has a thickness of between about 1 nm and about 50 microns.

8. The sensor device of claim 1, wherein the frame comprises a silicon frame.

9. The sensor device of claim 1, wherein the frame has a thickness of between about 50 microns and about 650 microns.

10. The sensor device of claim 1, wherein the thin film layer comprises a material selected from the group consisting of at least one dielectric material, polysilicon, parylene, polyimide, silicon oxinitride, and a combination of at least one of the foregoing materials.

11. The sensor device of claim 1, wherein the thin film layer has a thickness of between about 50 nm and about 5 microns.

12. The sensor device of claim 1, wherein the sensing layer is disposed directly or indirectly adjacent to the first surface of the thin film membrane.

13. The sensor device of claim 1, wherein the sensing layer is disposed directly or indirectly adjacent to the second surface of the thin film membrane.

14. The sensor device of claim 1, wherein the sensing layer comprises at least one of a thin film and a plurality of nano-scale particles.

15. The sensor device of claim 14, wherein the plurality of nano-scale particles comprise at least one of a plurality of nano-scale spheres, a plurality of nano-scale rods, and a plurality of nano-scale hollow fibers.

16. The sensor device of claim 1, wherein the sensing layer comprises a material selected from the group consisting of zeolite, a cross-linked organic polyelectrolyte, a self-assembled monolayer of ionic character, an aluminosilicate, a carbon nanostructure, and a combination of at least one of the foregoing materials.

17. The sensor device of claim 1, wherein the sensing layer has a thickness of between about 1 nm and about 5 microns.

18. The sensor device of claim 1, further comprising:

an additional thin film membrane disposed directly or indirectly adjacent to the thin film layer;

an additional frame disposed directly or indirectly adjacent to the additional thin film membrane, wherein one or more internal surfaces of the additional frame define at least one additional cell having at least two additional openings;

a porous grid structure disposed substantially within at least one of the two additional openings of the at least one additional cell defined by the one or more internal surfaces of the additional frame; and

an additional thin film layer disposed directly or indirectly adjacent to the additional frame.

19. The sensor device of claim 18, wherein the additional thin film membrane comprises a material selected from the group consisting of at least one dielectric material, polysilicon, and a combination of at least one of the foregoing materials.

20. The sensor device of claim 19, wherein the at least one dielectric material comprises a material selected from the group consisting of silicon, silicon oxinitride, parylene, polyimide, and a combination of at least one of the foregoing materials.

21. The sensor device of claim 18, wherein the additional thin film membrane has a thickness of between about 50 nm and about 5 microns.

22. The sensor device of claim 18, wherein the additional frame comprises an additional silicon frame.

23. The sensor device of claim 18, wherein the additional frame has a thickness of between about 50 microns and about 650 microns.

24. The sensor device of claim 18, wherein the additional thin film layer comprises a material selected from the group consisting of at least one dielectric material, polysilicon, parylene, polyimide, silicon oxinitride, and a combination of at least one of the foregoing materials.

25. The sensor device of claim 18, wherein the additional thin film layer has a thickness of between about 50 nm and about 5 microns.

26. The sensor device of claim 1, wherein at least a portion of the sensor device is substantially surrounded by an atmosphere comprising one of dry air and an inert gas.

27. A method for fabricating a miniaturized sensor device, comprising:

providing a silicon layer having a first surface and a second surface;

depositing a first thin film layer having a first surface and a second surface on the first surface of the silicon layer;

depositing a second thin film layer on the second surface of the silicon layer;

masking the first surface of the first thin film layer and selectively depositing a sacrificial layer on the first surface of the first thin film layer, wherein the sacrificial layer defines one or more exposed regions of the first surface of the first thin film layer;

depositing a conductive layer on a surface of the sacrificial layer and the one or more exposed regions of the first surface of the first thin film layer defined by the sacrificial layer;

removing the sacrificial layer and a portion of the conductive layer deposited on the surface of the sacrificial layer to form one or more resistive thin film heater/thermometer devices on the first surface of the first thin film layer;

selectively removing a portion of the second thin film layer;

selectively removing a portion of the silicon layer to form at least one cell, wherein the at least one cell is disposed directly or indirectly adjacent to the second surface of the first thin film layer, and wherein the cell is substantially aligned with the one or more resistive thin film heater/thermometer devices; and

disposing a sensing layer on at least one of the first surface of the first thin film layer and the second surface of the first thin film layer.

28. The method of claim 27, wherein the silicon layer has a thickness of between about 50 microns and about 650 microns.

29. The method of claim 27, wherein the first thin film layer and the second thin film layer each comprise a material selected from the group consisting of at least one dielectric material, polysilicon, and a combination of at least one of the foregoing materials.

30. The method of claim 29, wherein the at least one dielectric material comprises a material selected from the group consisting of silicon, silicon oxinitride, parylene, polyimide, and a combination of at least one of the foregoing materials.

31. The method of claim 27, wherein the first thin film layer and the second thin film layer each have a thickness of between about 50 nm and about 5 microns.

32. The method of claim 27, further comprising depositing a protective layer on a surface of the second thin film layer.

33. The method of claim 32, wherein the protective layer comprises a photoresist layer.

34. The method of claim 32, wherein the protective layer has a thickness of between about 1 micron and about 10 microns.

35. The method of claim 32, wherein selectively removing a portion of the second thin film layer comprises selectively removing a portion of the second thin film layer and the protective layer.

36. The method of claim 27, wherein the sacrificial layer comprises a photoresist layer.

37. The method of claim 27, wherein the sacrificial layer has a thickness of between about 1 micron and about 10 microns.

38. The method of claim 27, wherein the conductive layer comprises a material selected from the group consisting of at least one metal, polysilicon, heavily-doped silicon, silicon carbide, and a combination of at least one of the foregoing materials.

39. The method of claim 38, wherein the at least one metal comprises at least one of platinum, titanium, gold, chromium, nickel, copper, and aluminum.

40. The method of claim 27, wherein the conductive layer has a thickness of between about 1 nm and about 50 microns.

41. The method of claim 27, wherein the sensing layer comprises at least one of a thin film and a plurality of nano-scale particles.

42. The method of claim 41, wherein the plurality of nano-scale particles comprise at least one of a plurality of nano-scale spheres, a plurality of nano-scale rods, and a plurality of nano-scale hollow fibers.

43. The method of claim 27, wherein the sensing layer comprises a material selected from the group consisting of zeolite, a cross-linked organic polyelectrolyte, a self-assembled monolayer of ionic character, an aluminosilicate, a carbon nanostructure, and a combination of at least one of the foregoing materials.

44. The method of claim 27, wherein the sensing layer has a thickness of between about 1 nm and about 5 microns.

45. A microelectromechanical system, comprising:

a thin film membrane having one or more active membrane areas and one or more inactive membrane areas;

one or more resistive thin film heater/thermometer devices disposed directly or indirectly adjacent to the one or more active membrane areas of the thin film membrane;

a frame disposed directly or indirectly adjacent to the one or more inactive membrane areas of the thin film membrane; and

one or more low-thermal conductivity microstructures disposed between the one or more active membrane areas of the thin film membrane and the one or more inactive membrane areas of the thin film membrane.

46. The system of claim 45, wherein the thin film membrane comprises a material selected from the group consisting of at least one dielectric material, polysilicon, and a combination of at least one of the foregoing materials.

47. The system of claim 46, wherein the at least one dielectric material comprises a material selected from the group consisting of silicon, silicon oxinitride, parylene, polyimide, and a combination of at least one of the foregoing materials.

48. The system of claim 45, wherein the thin film membrane has a thickness of between about 50 nm and about 5 microns.

49. The system of claim 45, wherein the one or more resistive thin film heater/thermometer devices each comprise a material selected from the group consisting of at least one metal, polysilicon, heavily-doped silicon, silicon carbide, and a combination of at least one of the foregoing materials.

50. The system of claim 48, wherein the at least one metal comprises at least one of platinum, titanium, gold, chromium, nickel, copper, and aluminum.

51. The system of claim 45, wherein the one or more resistive thin film heater/thermometer devices each have a thickness of between about 1 nm and about 50 microns.

52. The system of claim 45, wherein the frame comprises a silicon frame.

53. The system of claim 45, wherein the frame has a thickness of between about 50 microns and about 650 microns.

54. The system of claim 45, wherein the one or more low-thermal conductivity microstructures each comprise a material selected from the group consisting of an oxide, a glass, a polyimide, a polymer, a nitride, and a combination of at least one of the foregoing materials.

55. The system of claim 45, wherein the one or more low-thermal conductivity microstructures each have a thickness of between about 1 micron and about 500 microns.

56. The system of claim 45, further comprising a self-assembled monolayer disposed directly or indirectly adjacent to the one or more active membrane areas of the thin film membrane.

57. A miniaturized sensor device, comprising:

a thin film membrane having one or more active membrane areas and one or more inactive membrane areas;

one or more resistive thin film heater/thermometer devices disposed directly or indirectly adjacent to the one or more active membrane areas of the thin film membrane;

a frame disposed directly or indirectly adjacent to the one or more inactive membrane areas of the thin film membrane;

one or more low-thermal conductivity microstructures disposed between the one or more active membrane areas of the thin film membrane and the one or more inactive membrane areas of the thin film membrane;

one or more stress relief structures disposed directly or indirectly adjacent to the one or more active membrane areas of the thin film membrane; and

one or more sensing films disposed directly or indirectly adjacent to the one or more stress relief structures.

58. The sensor device of claim 57, wherein the thin film membrane comprises a material selected from the group consisting of at least one dielectric material, polysilicon, and a combination of at least one of the foregoing materials.

59. The sensor device of claim 58, wherein the at least one dielectric material comprises a material selected from the group consisting of silicon, silicon oxinitride, parylene, polyimide, and a combination of at least one of the foregoing materials.

60. The sensor device of claim 57, wherein the thin film membrane has a thickness of between about 50 nm and about 5 microns.

61. The sensor device of claim 57, wherein the one or more resistive thin film heater/thermometer devices each comprise a material selected from the group consisting of at least one metal, polysilicon, heavily-doped silicon, silicon carbide, and a combination of at least one of the foregoing materials.

62. The sensor device of claim 61, wherein the at least one metal comprises at least one of platinum, titanium, gold, chromium, nickel, copper, and aluminum.

63. The sensor device of claim 57, wherein the one or more resistive thin film heater/thermometer devices each have a thickness of between about 1 nm and about 50 microns.

64. The sensor device of claim 57, wherein the frame comprises a silicon frame.

65. The sensor device of claim 57, wherein the frame has a thickness of between about 50 microns and about 650 microns.

66. The sensor device of claim 57, wherein the one or more low-thermal conductivity microstructures each comprise a material selected from the group consisting of an oxide, a glass, a polyimide, a polymer, a nitride, and a combination of at least one of the foregoing materials.

67. The sensor device of claim 57, wherein the one or more low-thermal conductivity microstructures each have a thickness of between about 1 micron and about 500 microns.

68. The sensor device of claim 57, wherein the one or more stress relief structures are disposed directly or indirectly adjacent to the one or more active membrane areas of the thin film membrane and the one or more low-thermal conductivity microstructures.

69. The sensor device of claim 68, wherein the one or more stress relief structures comprise:

one or more silicon layers disposed directly or indirectly adjacent to the one or more active membrane areas of the thin film membrane and the one or more low-thermal conductivity microstructures; and

one or more conformal layers disposed directly or indirectly adjacent to the one or more silicon layers and at least a portion of the frame.

70. The sensor device of claim 69, wherein the one or more silicon layers each have a thickness of between about 1 nm and about 10 nm.

71. The sensor device of claim 69, wherein the one or more conformal layers each comprise a material selected from the group consisting of an oxide, a nitride, and a combination of at least one of the foregoing materials.

72. The sensor device of claim 69, wherein the one or more conformal layers each have a thickness of between about 0.01 microns and about 1 micron.

73. The sensor device of claim 69, wherein the one or more sensing films are disposed directly or indirectly adjacent to the one or more conformal layers.

74. The sensor device of claim 57, wherein the one or more stress relief structures comprise:

one or more silicon layers disposed directly or indirectly adjacent to the one or more active membrane areas of the thin film membrane;

a plurality of substantially-parallel silicon microstructures disposed directly or indirectly adjacent to the one or more silicon layers, wherein the plurality of substantially-parallel silicon microstructures are aligned substantially perpendicular to the one or more silicon layers; and

one or more conformal layers disposed directly or indirectly adjacent to the one or more silicon layers and the plurality of substantially-parallel silicon microstructures.

75. The sensor device of claim 74, wherein the one or more silicon layers each have a thickness of between about 1 nm and about 10 nm.

76. The sensor device of claim 74, wherein the plurality of substantially-parallel silicon microstructures each have a length of between about 0.01 microns and about 10 microns.

77. The sensor device of claim 74, wherein the plurality of substantially-parallel silicon microstructures each have a width of between about 0.01 microns and about 10 microns.

78. The sensor device of claim 74, wherein the one or more conformal layers each comprise a material selected from the group consisting of an oxide, a nitride, and a combination of at least one of the foregoing materials.

79. The sensor device of claim 74, wherein the one or more conformal layers each have a thickness of between about 0.01 microns and about 1 micron.

80. The sensor device of claim 74, wherein the one or more sensing films are disposed directly or indirectly adjacent to the one or more conformal layers.